MERRIMACK RIVER BASIN

HILLSBOROUGH, NEW HAMPSHIRE

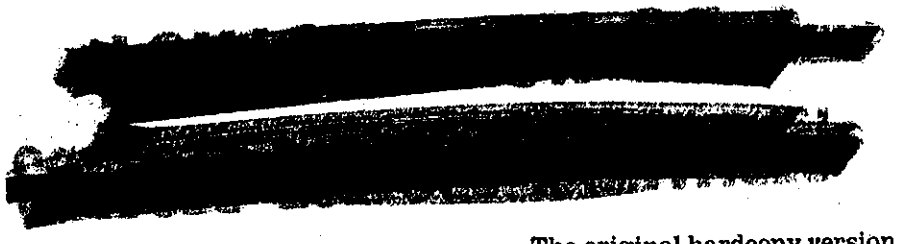
LAKE FRANKLIN PIERCE DAM

N.H. 00199

NHWRB-116.04

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

AUGUST 1978

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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Hillsborough New Hampshire
North Branch, Contoocook River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam consists of a central concrete gravity ogee spillway with earth dike embankments. THe dam is 1870 ft. long and 43 ft. high. THe dam is assessed to be in fair condition. No serious problems were detected, although some suspicious seepage was noted which should be monitored closely. Overtopping potential is considered high.

FORM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED-E

APR 16 1979

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

I am forwarding for your use a copy of the Lake Franklin Pierce Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment which emphasizes the inadequacy of the project spillway under test flood conditions is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Lake Franklin Pierce Dam would likely be exceeded by floods greater than 28 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Screening criteria for initial review of spillway adequacy specifies that this class of dam, having insufficient spillway capacity to discharge fifty (50) percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations there appears to be a serious deficiency in spillway capacity. This could render the dam unsafe in the event of a severe storm which would likely cause overtopping and possible failure of the dam, significantly increasing the hazard potential for loss of life downstream from the dam.

NEDED-E
Honorable Hugh J. Gallen

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy preciptiation, round-the-clock surveillance should be provided.

I have approved the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to Water Resources Board, the cooperating agency for the State of New Hampshire. This report has also been furnished to the owner of the project, the Public Service Company of New Hampshire, 1000 Elm Street, Manchester, New Hampshire 03101.

Copies of this report will be made available to the public, upon request to this office, under the Freedom of Information Act, thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for the cooperation extended in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

LAKE FRANKLIN PIERCE DAM

NH 00199

MERRIMACK RIVER BASIN
HILLSBORO, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam Lake Franklin Pierce Dam

State Located New Hampshire

County Located Hillsboro

City or Town Hillsboro

Stream North Branch, Contoocook River

Date of Inspection 6/22/78

BRIEF ASSESSMENT

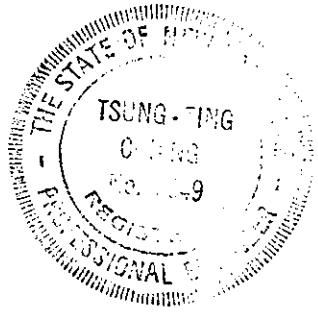
Lake Franklin Pierce Dam (also known as Jackman Dam) consists of a central concrete gravity ogee spillway with earth dike embankments. Total length is 1,870 feet and maximum height is 43 ft. The dam is located on the east end of Lake Franklin Pierce on the north branch of the Contoocook River in the Town of Hillsboro. A 7.5 ft. diameter penstock runs downstream from the dam a distance of 1.3 miles to the Jackman Hydroelectric Station. The dam is owned by the Public Service Company of New Hampshire and is operated for electric power. It is placed in the significant-to-high hazard classification due to its proximity above the village of Hillsboro.

Lake Franklin Pierce Dam is assessed to be in fair condition. The principal shortcoming is low spillway capacity. No other serious problems were detected, although some suspicious seepage was noted which should be monitored closely. Most of the long embankments are heavily covered with trees which can cause uprooting in wind storms and whose roots can provide leakage paths.

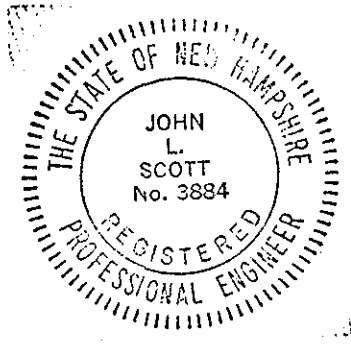
A test flood equal to the probable maximum flood would overtop the dam by six feet (4 ft. if the trees were cleared). Spillway capacity is equal to about 1/4 the peak outflow of the probable maximum flood. Overtopping potential is considered high.

It is recommended that the Owner take steps to improve the hydraulic capacity, monitor the apparent seepage, and remove all trees from the embankments within two years after receipt of this Phase I Report.

WHITMAN & HOWARD, INC.



T. T. Chiang, Ph.D., P.E.



John L. Scott, P.E.

This Phase I Inspection Report on Lake Franklin Pierce Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Charles G. Tiersch

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

Fred J. Ravens Jr.

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

Saul Cooper

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fraction thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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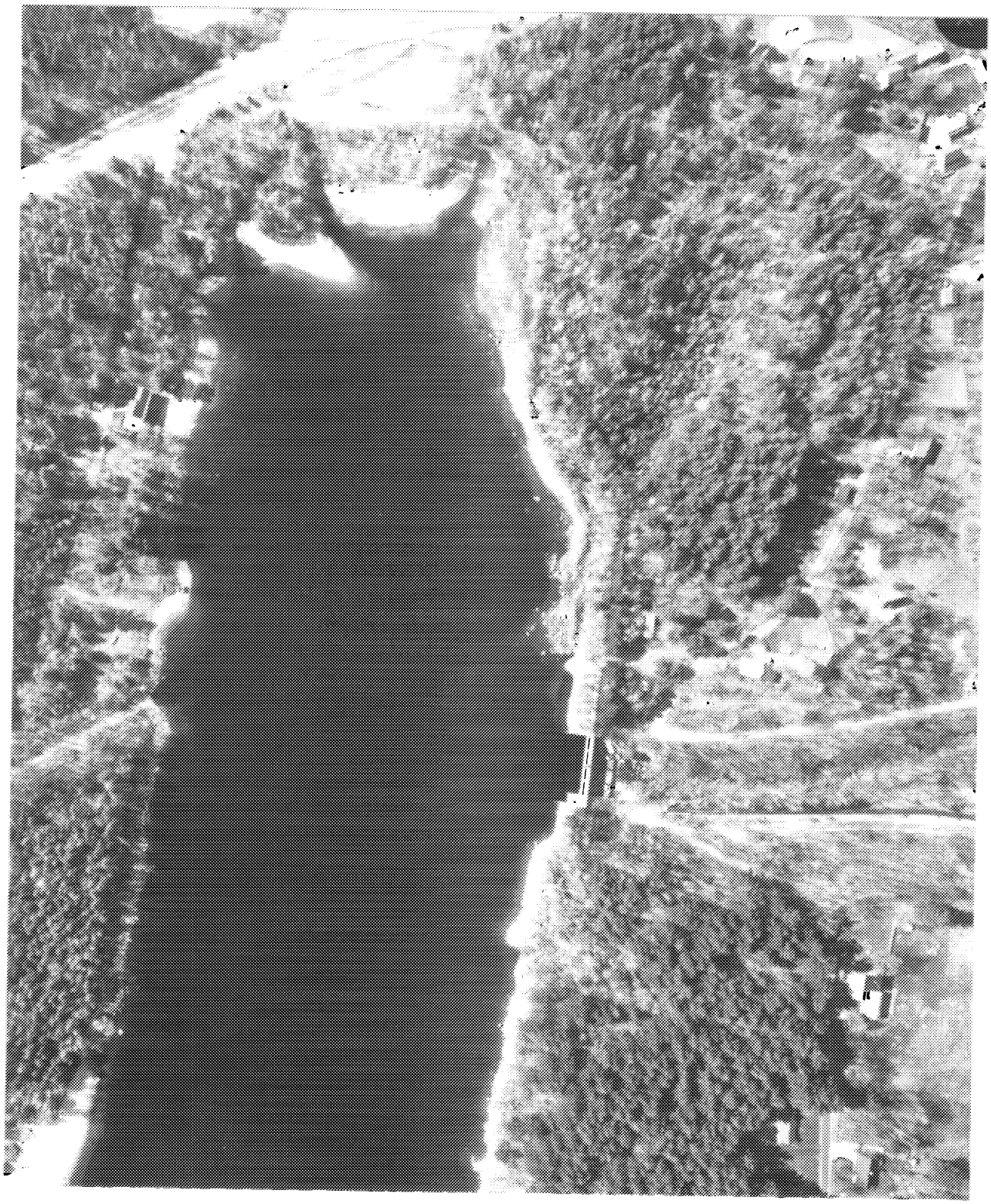
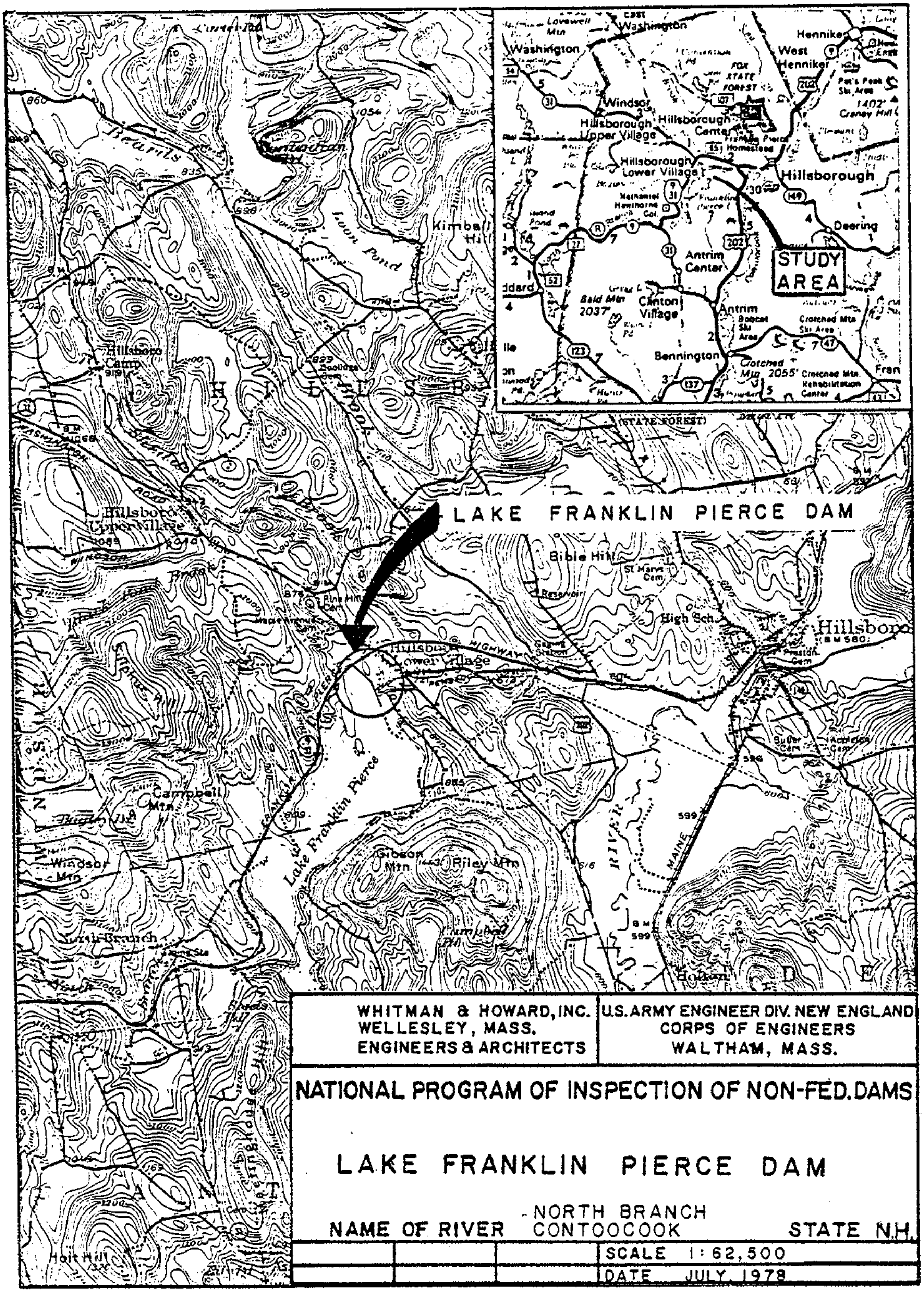


LAKE FRANKLIN PIERCE DAM

Hillsborough, N.H.

Approx. Scale 1" = 280'



WHITMAN & HOWARD, INC.
WELLESLEY, MASS.
ENGINEERS & ARCHITECTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE FRANKLIN PIERCE DAM

NAME OF RIVER NORTH BRANCH CONTOOCOOK STATE N.H.

SCALE 1:62,500

DATE JULY 1978

PHASE I INSPECTION REPORT

LAKE FRANKLIN PIERCE DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Whitman & Howard, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to Whitman & Howard, Inc. under a letter of May 1, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0313 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and prepare the States to quickly initiate effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location

Lake Franklin Pierce Dam is located on the east end of Lake Franklin Pierce on the North Branch of the Contoocook River in the Town of Hillsboro, New Hampshire. It appears on the U.S.G.S. quadrangle "Hillsboro, New Hampshire". Lake Franklin Pierce is also known as Jackman Reservoir and the dam is sometimes called Jackman Dam.

b. Description of Dam and Appurtenances

Lake Franklin Pierce Dam consists of a central concrete gravity ogee spillway with earth dike embankments. The concrete section is 130 feet long, the north embankment is 1,340 feet long and the south embankment is 400 feet long, for an overall dam length of 1,870 feet. Maximum height from top of embankment to bottom of the downstream apron is 43 feet. The spillway has an active length of 104 feet and has thirteen feet of free board. Flash boards 4'-6" high are regularly used.

A four foot square sluiceway is located through the base of the spillway near the south abutment. A 7-1/2 foot diameter wooden penstock runs from the dam approximately 6,700 feet (the longest such penstock in New Hampshire) to the 3,400 KW Jackman Hydrolectric Plant located on the Flat west of Hillsboro. Intake for the penstock is on the south abutment and the control device is a radial gate operated manually from the top of the dam.

c. Size Classification

For the purposes of this report, dams are placed in size classes according to the following table:

Category	Storage (ac.-ft.)		Height (ft.)
Small	less than 1,000	and	less than 40
Intermediate	between 1,000 & 50,000	or	between 40 and 100
Large	over 50,000	or	over 100

Lake Franklin Pierce Dam, with a storage of 8,400 ac.-ft. and a height of 43 ft., is in the "Intermediate" size classification.

d. Hazard Classification

Lake Franklin Pierce Dam discharges to the natural stream bed of the North Branch, which drops about 125 ft. in the 1.3 miles to the Hydroelectric Plant. No significant dwellings or high value property lie in this stretch. The valley broadens and flattens out from that point where it joins the main branch of the Contoocook River, just west of the village area of Hillsboro. This flat area is about 2 to 3 times the surface area of Lake Franklin Pierce, and sudden failure of the dam would place about 10 feet of water there. While the village would definitely suffer some damage, the flood wave would be dampened in this broad area. Therefore Lake Franklin Pierce Dam is placed in the "Significant-to-High" hazard class.

e. Ownership

The dam was built by, and is owned by the Public Service Company of New Hampshire, the largest electric utility company in New Hampshire.

f. Operator

Leon Brooks, Operating Superintendent
Public Service Company of New Hampshire
1000 Elm Street
Manchester, New Hampshire 03101 603-669-4000

g. Purpose of Dam

The dam was built and is actively operated today for generation of electric power. A secondary purpose is for recreation.

h. Design and Construction History

The dam was built in 1926 and is the key element in the Jackman Power Development Project for Public Service Company of New Hampshire. The dam was designed by Vaughan Engineers of Boston. In order to build the dam, the Owners acquired and cleared the flooded land and performed a lengthy relocation of the highway which is now Route 9.

A good visual record of construction was kept and survives today in the form of 225 5 x 7 photographs.

The penstock was damaged severely by ice and high water in 1956 and underwent extensive repairs, during which the channel of the North Branch was relocated in one place to prevent future damage. The hydro plant was inactive for a time in the early 70's and was reopened recently after complete replacement of the upper 1200 ft. of the penstock.

A 25 ft. long section of the south abutment concrete wall was rebuilt in 1963. It is not known why this was necessary.

The basic dam configuration has remained unchanged since its construction.

i. Normal Operating Procedures

An attempt is made to follow a "standard line" of lake level generally with level equal to top of flash boards (767.7) from late August through early July. From that time, an even decline is allowed to a low point of about 745 in March. The spring run-off brings the level steeply back up in May. Flash boards are removed in October and replaced after the spring snow melts.

The Hydroelectric Plant is operated year round.

1.3 Pertinent Data

a. Drainage Area

Total drainage area is 69.0 square miles, of which 33 square miles are tributary to Highland Lake. This body of water was originally three lakes, and was made into one by a dam at the now south end. The northern-most of the three lakes actually drained into Shedd Brook and was not tributary to the location of Lake Franklin Pierce. There is reportedly a dike across this "North Outlet" of unknown height. In order to be conservative, the hydrologic computations performed for this report assume a full contribution from Highland Lake, even though some of the upper drainage area would spill into Shedd Brook during general flooding.

The drainage area terrain is quite rugged and is hydrolically classified as mountainous-to-rolling.

b. Discharge at Damsite

(1) Maximum known flood - Unknown

(2) Flow capacity at maximum pool elevation

Spillway	18,500	
4' sluice	1,000	
Penstock	400	
TOTAL	19,900	say 20,000 cfs

c. Elevation (ft. above MSL)

(1) Top Dam - 776.2

(2) Maximum pool - design surcharge - 771.2 (8' above spillway)

(3) Full flood control pool - N/A

(4) Recreation Pool - 767.7 (top of flashboards)

(5) Spillway crest - 763.22

(6) Upstream portal invert diversion tunnel - 731.47 (Penstock)

(7) Streambed at centerline of dam - Approx. 733

(8) Maximum tailwater - Unknown

d. Reservoir

(1) Length of maximum pool - 13,600 ft.

(2) Length of recreation pool - 13,500 ft.

(3) Length of floor control pool - N/A

e. Storage (acre-feet)

(1) Recreation pool - 8360

(2) Flood control pool - N/A

(3) Design surcharge - 9,920

(4) Top of dam - 12,400

f. Reservoir Surface (acres)

(1) Top dam - Est. 511

(2) Maximum pool - Est. 496

(3) Flood-control pool - N/A

(4) Recreation pool - 486

(5) Spillway crest - 463

g. Dam

(1) Type - Concrete gravity overflow section, earth embankments

(2) Length - Total 1,870 ft.

(3) Height - 43 ft., top of embankment to d.s. apron

(4) Top Width - Embankments 8'-0"

(5) Side Slopes - u.s. 2.5:1, d.s. 2:1

(6) Zoning - "Selected material" upstream; impervious core; "coarse material" downstream

(7) Impervious Core - "40% clay, 60% sand"

(8) Cutoff - 6' x 6' trench

(9) Grout curtain - N/A

h. Diversion and Regulating Tunnel

(1) Type - 7.5 ft. diam. penstock, of concrete thru dam then wooden stave to hydro station

(2) Length - Penstock 6,700 ft.

(3) Closure - 7.5' x 7.5' radial gate on penstock

(4) Access - Manual gear drive atop south abutment

(5) Regulating Facilities - All manual, except level recorder telemetered to hydro station

i. Spillway

(1) Type - Concrete ogee

(2) Length of weir - 4 bays @ 26'= 104'

(3) Crest elevation - 763.22

(4) Gates - 4.5' flashboards used regularly

(5) U/S Channel - on-stream

(6) D/S Channel - concrete apron leads to natural stream bed

(7) General - 45 flashboard pins - 3" O.D. pipe, 1/4" wall thickness

j. Regulating Outlets

(1) Invert - 733

(2) Size - 4' x 4'

(3) Description - Sluiceway formed thru dam

(4) Control Mechanism - Sluice gate

SECTION 2: ENGINEERING DATA

2.1 Design

Designer of the project was Vaughan Engineers of Boston, Mass. Design plans are lengthy (55 sheets) and are exhaustively detailed.

The central concrete spillway section has a main element of a mass concrete gravity section with two concrete cutoffs at the base, and aprons upstream and downstream each with a concrete cutoff at the extremity. Large boulders were permitted to be embedded in the mass concrete sections. The north abutment is a large reinforced concrete retain wall. The south abutment is a retaining wall buttressed to the lower concrete penstock sections near the base, all of which is covered by the earthfill of the south embankment.

The embankments are zoned as described in Section 1.3 g and are shown on the plate in Appendix B. They are designed for an 18-inch layer of riprap on the upstream base. Both upstream and downstream slopes have a rock fill toe.

2.2 Construction

A fairly good visual record of construction exists in the form of 225 5 x 7 photographs taken throughout the progress of the job.

Extensive written memoranda exists, but pertain mostly to administrative details.

2.3 Operation

Lake level records are kept, as well as various data on the operation of the hydro station.

2.4 Evaluation

a. Availability

Design - Excellent. Full set of very detailed plans.

Construction - Good. Many photos to give good visual record. No analysis on the foundation or geology however.

b. Adequacy - The data available are sufficient to form an accurate general picture of the project, but information in key areas is missing so firm conclusions cannot be reached.

c. Validity - Good. The plans, photographs and visual inspection reveals the dam was constructed in good conformance to the plans.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

Water level was about 12 inches below the top of the flashboards on the day of the inspection, and a small quantity of flow was leaking through the boards.

b. Dam

The concrete surface of the spillway is moderately eroded, and is judged about normal considering the age of the dam. Construction joints are eroded up to about 6 inches deep. Seepage could not be determined due to flow on the spillway. The stepped toes on the north part of the spillway were spalled to the point of exposing reinforcing bars. The north abutment face seemed good except for the bottom of the corner where a short wing wall juts away from the abutment. Here there is a hole probably caused by impact. The south abutment wall looks quite good, being new in 1963. The lower part not rebuilt appears to have been gunited.

The 4-ft. square sluiceway is in good condition. The owner's representative declined to operate the sluiceway gate, since it hadn't been used recently. No leakage was noticed, but its condition is questionable.

Nine weep holes were observed near the downstream toe of the spillway. Two were apparently filled with concrete and the other seven were open to depth from 0.3 to 1.3 feet. No water appeared to be discharging from any of these.

The south abutment had seven weep holes located eight feet above the apron. All seven were discharging a small amount of water.

There are seven weep holes in the downstream apron about 13 feet downstream from the bottom of the spillway. These weep holes consisted of vertical tile pipes and all of them appeared to be clogged. In the north abutment, 6 weep holes were observed. The three highest were not discharging water, but there was staining beneath the lowest of the three indicating discharge at some time in the past. The lower three weep holes were discharging water.

The upstream face of the spillway was not visible beneath the surface of the water.

The south embankment is covered with trees and brush on all surfaces except the downstream face close to the south abutment where there are no trees. The upstream face of the dike is covered with riprap and the entire dike was above the reservoir level at the time of the inspection. Seepage was occuring on the downstream slope of this embankment near the south abutment and also in the south side of the trench where the penstock exits from the toe of the slope. It was not possible to determine whether these two seepages are the result of flow under and through the embankment or of the natural discharge of groundwater from the south side of the valley.

The north embankment is also covered with trees and brush all over, with the exception of a path worn on the crest and a short vehicle access road. The upstream slope is covered with riprap and the entire dike was above reservoir level at the time of the inspection. Seepage was occuring at the toe of downstream slope adjacent to the north abutment. It was not possible to determine whether this seepage is the result of flow under and through the embankment or of the natural discharge of groundwater.

c. Pertinent Structures

The wood stave penstock had a few minor leaks, not unusual for this type of construction.

The gate operating mechanisim appeared to be in serviceable condition though gate operation was not observed.

d. Reservoir Area

Low density cottage development exists around portions of the lake shore.

e. Downstream Channel

The downstream channel is covered with sand, gravel, and boulders. There is a heavy growth of trees and brush along the banks of the channel, and some of the brush in encroaching on the channel.

3.2 Evaluation

No evidence was uncovered of gross structural instability, though the seepages bear watching.

The seepage at the south abutment could be the result of leakage in the concrete penstock beneath this area. It could also be seepage through the embankment or merely groundwater not associated with the dam.

The extensive tree growth on both embankments could lead to problems during a blow down or could lead to seepage along dead roots.

Trespassing is extensive and the loss of vegetation caused thereby could lead to unacceptable long-term erosion. Moderate vandalism damage was also noted.

SECTION 4: OPERATIONAL PROCEEDINGS

4.1 Procedures

An attempt is made to regulate lake levels to a "standard line". See graph in appendix B.

4.2 Maintenance of Dam

Frequent observation visits are performed and general maintenance is carried out as necessary. The effort appears to be conscientious but not outstanding.

Trees have been allowed to grow probably starting just after construction.

4.3 Maintenance of Operating Facilities

An inspection by Water Resources Board personnel in November 1973 revealed the penstock gate to be leaking considerably. It is not known whether this condition has been remedied. The penstock has been repaired extensively in 1956 and 1974. Again, maintenance appears to be conscientious but not outstanding.

4.4 Description of any Warning System in Effect

No formal warning system is known to be in effect.

4.5 Evaluation

Operational procedures appear to be adequate.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

Design engineer's computations on hydrology are not available. Criteria for selecting spillway capacity are not known.

b. Experience Data

No records were uncovered of the dam's performance in floods or other hydrologic events.

c. Visual Observation

No evidence of previous overtopping was observed. Numerous bent flash board pins were seen scattered in the downstream channel, indicating they probably release properly.

d. Overtopping Potential

Reference is made to appendix D for the hydrologic computations performed as part of this report.

The probable maximum flood (PMF) for this site is computed to be about 82,000 cfs inflow into Lake Franklin Pierce. The probable maximum flood is defined as the largest flood that can reasonable be expected to occur on a given stream at a selected point, or the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

For dams of the size and hazard classifications of Lake Franklin Pierce Dam, the "test flood" is generally chosen between one half of the PMF and the full PMF. The test flood is that flood used to determine the hydraulic adequacy of a project. Due to the steepness in the downstream channel, the test flood is chosen as the full PMF.

During a PMF event, the peak outflow at the dam would be about 71,000 cfs, the reduction from 82,000 cfs inflow being accounted for by the surcharge storage "cushioning" effect of the impoundment. The total spillway capacity of the dam is about 20,000 cfs, or 28% of the peak outflow. Overtopping potential is considered to be high. An outflow of 71,000 cfs would overtop the embankment by about 6 ft. (4 ft. if the dike were cleared of trees).

As mentioned in 1.3a, Highland Lake is not fully tributary to Lake Franklin Pierce. An analysis of this situation is beyond the scope of this report. Before any hydraulic improvements to this dam are contemplated, a detailed flood routing study should be performed taking the hydrologic irregularity of Highland Lake into consideration.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observation

No cracks, piping, boils, or other signs of serious instability were detected.

About half of the weep holes in the various portions of the weep hole section were operating correctly.

Concrete condition is generally good considering the age of the structure, with a few problem locations. Erosion of the spillway was moderate and normal, but of course will progress. Repair will be necessary at some future time.

Seepage occuring at the embankment toes should be monitored, as these may be the onset of more serious problems.

b. Design and Construction Data

The design was quite detailed, and although an analysis of the plans was not performed, they appear to be quite thorough.

The construction photos indicate the configuration and intent of the design was carried out.

Unfortunately, too many gaps in the data are present to allow for comfortable conclusions to be reached.

c. Operating Records

No operating records exist which bear upon a structural stability evaluation.

d. Post Construction Changes

A 25 ft. section of the south abutment was rebuilt in 1963. The reason for the rebuilding is not known.

e. Seismic Stability

The dam is located in a Seismic Zone #2 and hence does not need to be evaluated for seismic stability according to the OCE recommended guidelines.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

Lake Franklin Pierce Dam is assessed to be in overall fair condition. Some problems exist whose origin may be serious enough to warrant corrective action. Hydraulic adequacy is poor and embankment slopes have been neglected.

b. Adequacy of Information

The information available is sufficient to form a good general picture of the important features of the project, but lack the continuity to reach definite conclusions. The assessment is based primarily on the design plans, construction photographs, and visual inspections.

c. Urgency

The recommendations and remedial measures mentioned below should be carried out by the owner within two years after receipt of this Phase I Report.

d. Need For Additional Investigation

No need exists for additional investigations at this time.

This dam should be thoroughly inspected by a competent engineer every two years, in addition to regular observation visits by maintenance personnel.

7.2 Recommendations

a. All trees and shrubs on all embankment surfaces and for a distance 25 ft. downstream of the toes should be removed. A competent engineer should be retained to supervise removal of roots and proper backfilling. A grass cover should be established and maintained.

b. The owner should engage professional assistance to perform a detailed hydrologic analysis and to make recommendations for improving the spillway capacity and/or armoring the embankments against washout.

7.3 Remedial Measures

a. Alternatives-N/A

b. Operating and Maintenance Procedures

(1) The Owner should adopt a more aggresive program of preventing trespass on the dam.

(2) Round the clock surveillance should be provided by the owner during periods of unusually high flows caused by heavy precipitation, rapid snowmelt, or other reasons. The owner should develop a formal warning system with local officials for alerting downstream residents in case of emergency.

(3) The spalled and broken concrete areas should be properly patched.

(4) Monitor the embankment seepage at the toes of both embankments adjacent to the abutments.

(5) Restore all weep holes to operating condition.

LAKE FRANKLIN PIERCE DAM

APPENDICES

Appendix	Description
A	Visual Inspection Checklist - 8 pp.
B	Engineering Data
C	Inspection Photographs with Index - 12 photos
D	Hydrologic Computation
E	Information as Contained in the National Inventory of Dams

APPENDIX A

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Lake Franklin Pierce Dam
New Hampshire

DATE June 22, 1978

TIME 10:00 A.M.

WEATHER Sunny, Warm

W.S. ELEV. 766.7 U.S. 733 DN.S.
(1' below flashboards)

PARTY:

1. T.T. Chiang, W&H
2. John Scott, W&H
3. Ronald Hirschfield, GEI
4. W. Parker Farmer, PS of NH
5. Leon Brooks, PS of NH
6. Robert Brecknock, PS of NH
7. _____
8. _____
9. _____
10. _____

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT Lake Franklin Pierce Dam, NH DATE June 22, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	Not applicable. Embankment sections on both sides of concrete gravity section are above normal pool elevation and are considered as dikes.
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indication of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection-Riprap Failures	
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	

PERIODIC INSPECTION CHECK LIST

PROJECT Lake Franklin Pierce Dam, NH DATE June 22, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	None observed.
Pavement Condition	No paving.
Movement or Settlement of Crest	None observed.
Lateral Movement	None observed.
Vertical Alignment	Good.
Horizontal Alignment	Good.
Condition at Abutment and at Concrete Structures	Good.
Indication of Movement of Structural Items on Slopes	None observed.
Trespassing on Slopes	Extensive trespassing on crest of north dike and on upstream slope of north dike near concrete gravity section.
Sloughing or Erosion of Slopes or Abutments	None observed.
Rock Slope Protection-Riprap Failures	None observed.
Unusual Movement or Cracking at or near Toes	None observed.
Unusual Embankment or Downstream Seepage	Seepage at several locations near downstream tow of both north and south dikes near concrete gravity section.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Toe Drains	None observed.
Instrumentation System	

PERIODIC INSPECTION CHECK LIST

PROJECT Lake Franklin Pierce Dam, NH DATE June 22, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS-INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	Not applicable.
Bottom Conditions	Not visible under water.
Rock Slides or Falls	None.
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	None.
b. Intake Structure	
Condition of Concrete	Concrete at water line shows considerable ice damage.
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT Lake Franklin Pierce Dam, NH DATE June 22, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS-TRANSITION AND CONDUIT	Penstock
General Condition of Concrete	- Headwall where wood penstock exits from embankment - seepage alongside
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	- Penstock leaks in several spots - apparently normal for wood stave pipe. Pipe new in '74.
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST

PROJECT Lake Franklin Pierce Dam, NH DATE June 22, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Apron - moderately eroded surface
Rust or Staining	
Spalling	Some spalling at sharp corners
Erosion or Caviation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	Drain holes in concrete apron and wingwalls downstream of overflow spillway, some discharging water, some apparently plugged.
Channel	
Loose Rock or Trees Overhanging Channel	Trees adjacent to channel.
Condition of Discharge Channel	Good.

PERIODIC INSPECTION CHECK LIST

PROJECT Lake Franklin Pierce Dam, NH DATE June 22, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None.
Floor of Approach Channel	Not visible beneath water.
b. Weir and Training Walls	
General Condition of Concrete	Good except for a few areas.
Rust or Staining	
Spalling	Spalling severe at stopped toes near north abutment (see next comment).
Any Visible Reinforcing	Rebar exposed at this point.
Any Seepage or Efflorescence	
Drain Holes	None.
c. Discharge Channel	
General Condition	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Trees adjacent to channel.
Floor of Channel	Sand, gravel, and boulders.
Other Obstructions	None observed.

PERIODIC INSPECTION CHECK LIST

PROJECT Lake Franklin Pierce Dam, NH DATE June 22, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS-SERVICE BRIDGE	
a. Super Structure	Walkway over crest in excellent condition. Railing sound. Vandals have wrecked some electrical conduit.
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

APPENDIX B

ENGINEERING DATA

Plate - Plan and Section - redraw from construction plans

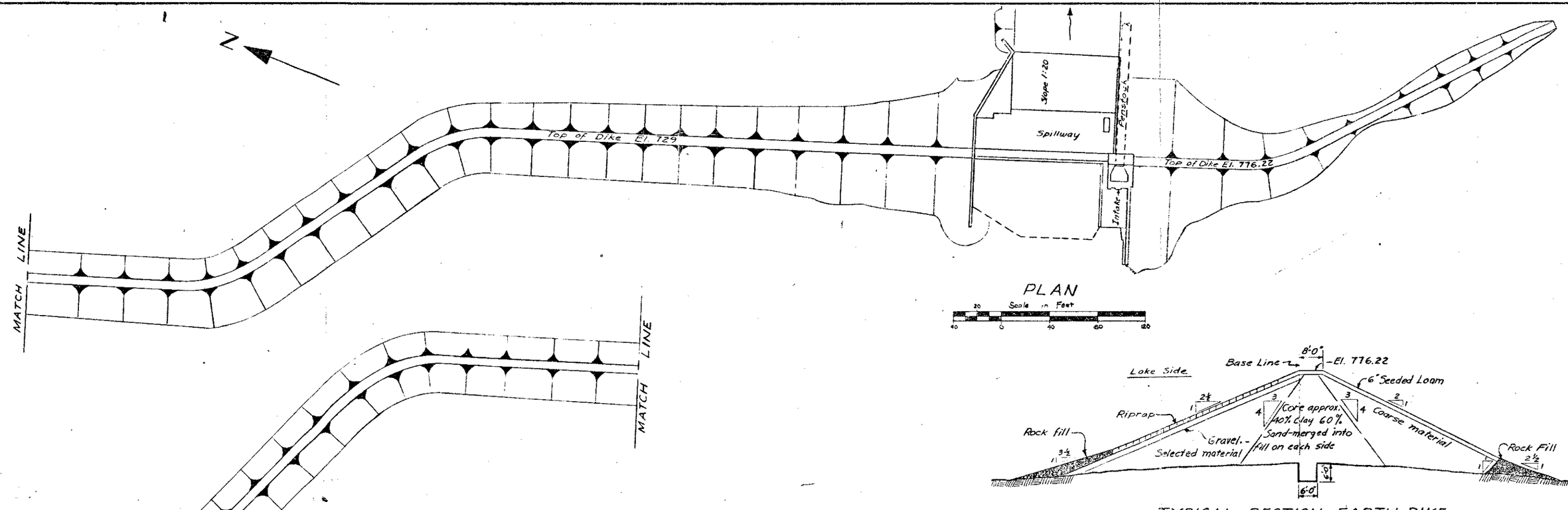
Letter from NH Water Resources Board to owner regarding inspection, 11/1/74

Plans for rebuilding section of south abutment, 1963

Graph of "Standard Line" for lake levels, 1950

State data on dam - 3 pages, 12/15/38

7 construction photos, 1926

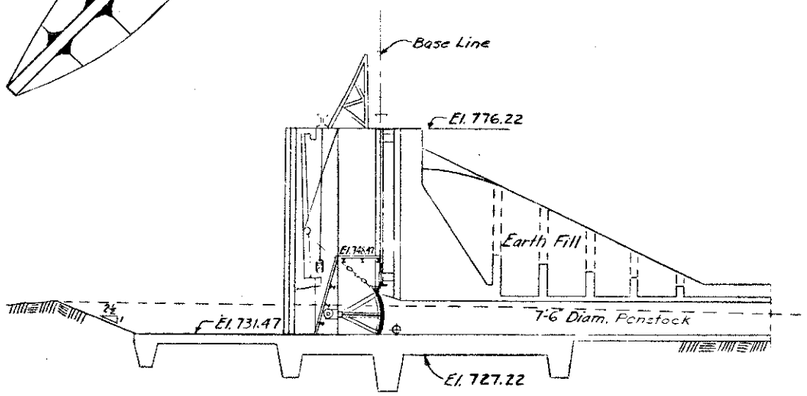


PLAN

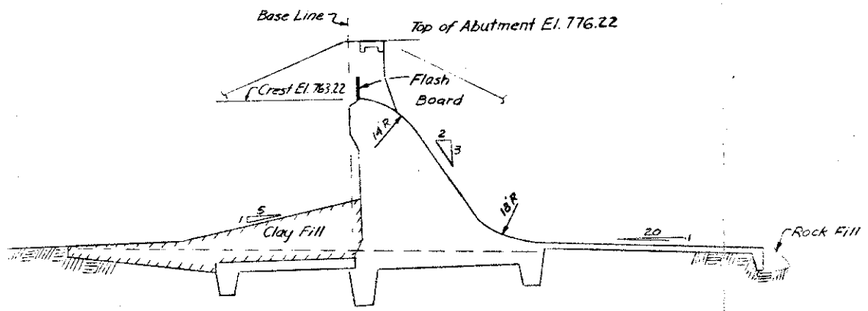
Scale in Feet

20 0 40 60 120

TYPICAL SECTION - EARTH DIKE



TYPICAL SECTION - INTAKE



TYPICAL SECTION - SPILLWAY

Scale in Feet

16 0 16 32 48

SAME SCALE FOR ALL SECTIONS

Note:
All elevations are USGS mean sea level datum.
Traced from print of original plan dated July 1925, modified to suit.

WHITMAN & HOWARD INC. ENGINEERS AND ARCHITECTS WELLESLEY, MASS.	US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE FRANKLIN PIERCE DAM

CONTOOCOOK RIVER — NEW HAMPSHIRE

SCALE AS SHOWN

DATE AUGUST, 1978

WATER RESOURCES BOARD

37 Pleasant St.
Concord 03301

November 1, 1974

Mr. John Lyons
Public Service Company of New Hampshire
Manchester, NH 03101

Re: Jackman Reservoir - Hillsboro - #116.04

Dear Mr. Lyons:

The Jackman Reservoir or the Franklin Pierce Lake Dam was inspected a few months ago by two of our engineers, and they reported that in general the dam was in good condition. No visible cracks were seen in the concrete structure. No noticeable leaks of any sort were found at the toe of the dam. However, tree and brush growth were found in abundance on both banks upstream and downstream. Even though the penstock gate was closed as tight as possible, the amount of water leaking through the penstock was quite high.

The following corrective measures are recommended:

(1) Cut and remove all trees and brush from both banks upstream and downstream.

(2) The penstock gate should be sealed tight and be free from any leaks.

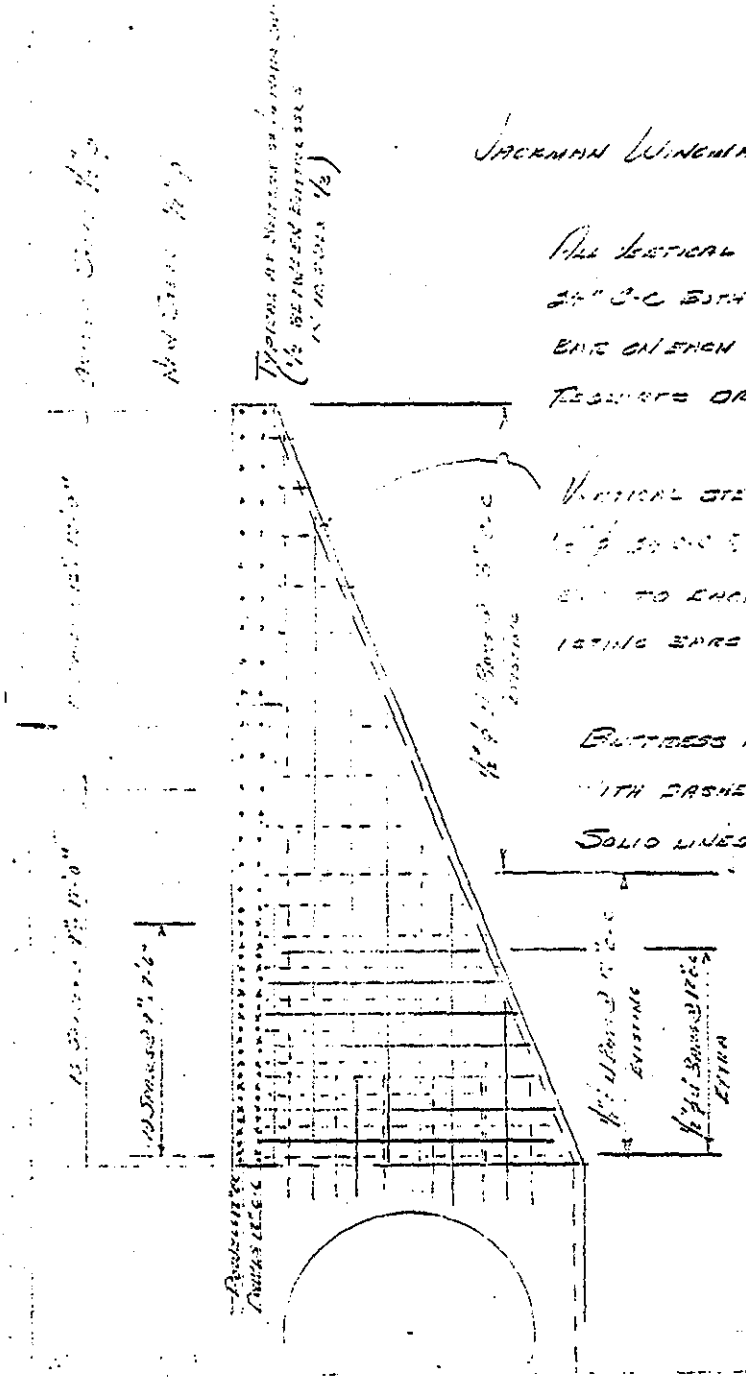
If you have any questions, please feel free to contact us at your convenience.

Sincerely yours,

George M. McGee, Sr.
Chairman

gmmg/pdk:js

GENERAL PLAN
DAM AND APPURTENANCES
JACKMAN STATION
Scale 1" = 40'



JACKMAN WINGWALL.

ALL VERTICAL STEEL IN WALL IS NOW ½" @ 24" C-C BOTH FACES. ADD ONE ½" BAR ON EACH FACE TO MAKE 12" C-C. REQUIRE DRILLING IN THE INSIDE COURSE

VERTICAL STEEL IN BUTTRESS IS NOW ½" @ 24" C-C BOTH FACES. ADD ONE ½" BAR TO EACH FACE BETWEEN EXISTING BARS TO MAKE 12" C-C SPACING

BUTTRESS REINFORCING SHOWN WITH DASHED LINES IS EXISTING. SOLID LINES INDICATE NEW STEEL

EXISTING HORIZONTAL WALL REINFORCING IS SHOWN AS (•) NEW STEEL IS SHOWN WITH AN (×).

SCALE 1/4" = 1'-0"

RETINAL ISCHEMIA
NEOVASCULARIZATION
EDGE

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 116.04

Town Hillsboro : County Hillsboro

Stream Jackman Reservoir

Basin-Primary Merrimack R. : Secondary Contoocook R.

Local Name

Coordinates—Lat. 43° 05' + 10,500 : Long. 71° 55' + 8700

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 69 Sq. Mi.

Overall length of dam 1870 ft.: Date of Construction 1926-27

Height: Stream bed to highest elev. 43 ft.: Max. Structure 32 ft.

Cost—Dam : Reservoir

DESCRIPTION O Gee Dam—— Earth dikes—— Earth Stone Concrete

Waste Gates

Type

Number 1 : Size 7.5 ft. high x 7.5 ft. wide

Elevation Invert 31.75 : Total Area sq. ft.

Hoist

Waste Gates Conduit 2 stop gates 7.5 in front of roller gate which

Number : Materials covers opening 7.5 square

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction

Length—Total 104 ft.: Net 4 bays 26' each ft.

Height of permanent section—Max. ft.: Min. ft.

Flashboards—Type Automatic : Height 8 ft.

Elevation—Permanent Crest 763.22 U S G S : Top of Flashboard

Flood Capacity cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 11 ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER P S Co of N H Manchester N H

REMARKS Hydro Electric Power—— Public Utility

Tabulation By A A N & R L T Date December 15, 1938.

B&B21234

7205

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON RESERVOIRS & PONDS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 116.04

Town Hillsboro : County Hillsboro

Stream Jackman Reservoir

Basin—Primary Merrimack R. : Secondary Contoocook R.

Local Name

DRAINAGE AREA

Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 69 Sq. Mi.

ELEVATION vs. WATER SURFACE AREA vs. VOLUME

Point	Head Feet	Surface Area Acres	Volume Acre Ft.
(1) Max. Flood Height			
(2) Top of Flashboards			
(3) Permanent Crest			
(4) Normal Drawdown			
(5) Max. Drawdown	24	519.43	9200
(6) Original Pond	U.S.G.S. 774		

Base Used .....: Coef. to change to U.S.G.S. Base .....

RESERVOIR CAPACITY

	Total Volume	Useable Volume
Drawdown	ft.	ft.
Volume	ac. ft.	ac. ft.
Acre ft. per sq. mi.		
Inches per sq. mi.		

USE OF WATER Hydro Electric— Public Utility

OWNER P S Co of N H Manchester N H

REMARKS

Tabulation By A A N & R L T Date December 15, 1938.

7206

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 116.04

Town Hillsboro: County Hillsboro

Stream Jackman Reservoir

Basin-Primary Merrimack R.: Secondary Contoocook R.

Local Name

GENERAL DATA

Head-Max. 168 ft.: Min. ft.: Ave. ft.

Date of Construction 1926-1927: Use of Power Hdro Electric & Public Utility

Pondage 9200 ac. ft.: Storage ac. ft.

DESCRIPTION

Racks

Size of Rack Opening

Size of Bar: Material

Area: Gross Sq. Ft.: Net sq. ft.

Head Gates

Type

Number: Size ft. high x ft. wide

Elevation of Invert: Total Area sq. ft.

Hoist

Penstock

Number: Material

Size: Length

Turbines

Number 1 : Makers Newport News Vertical 9' dia

Rating HP. per unit 5250: Total Capacity HP.

Max. Dement C.F.S., per unit: Total cfs.

Drive

Type

Generator

Number 1

Make G.E. 2300 V- 1005 Arm Amps- 275 Field Amps 300 R P M

Rating KW., per unit 3200; Total Capacity K. W.

Exciter

Number: Make

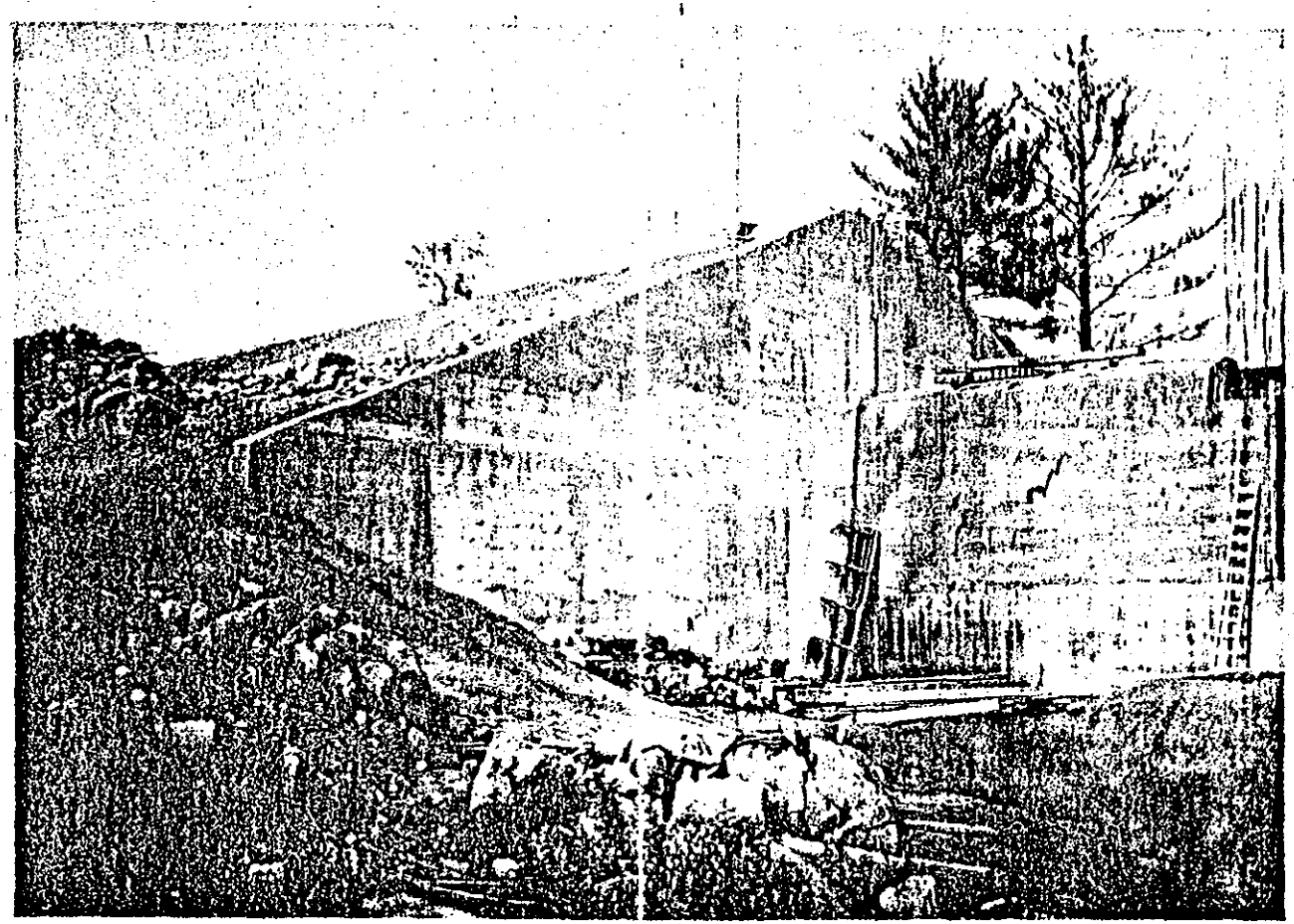
Rating-per unit: Total Capacity K. W.

OUTPUT—KWHRS

19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	

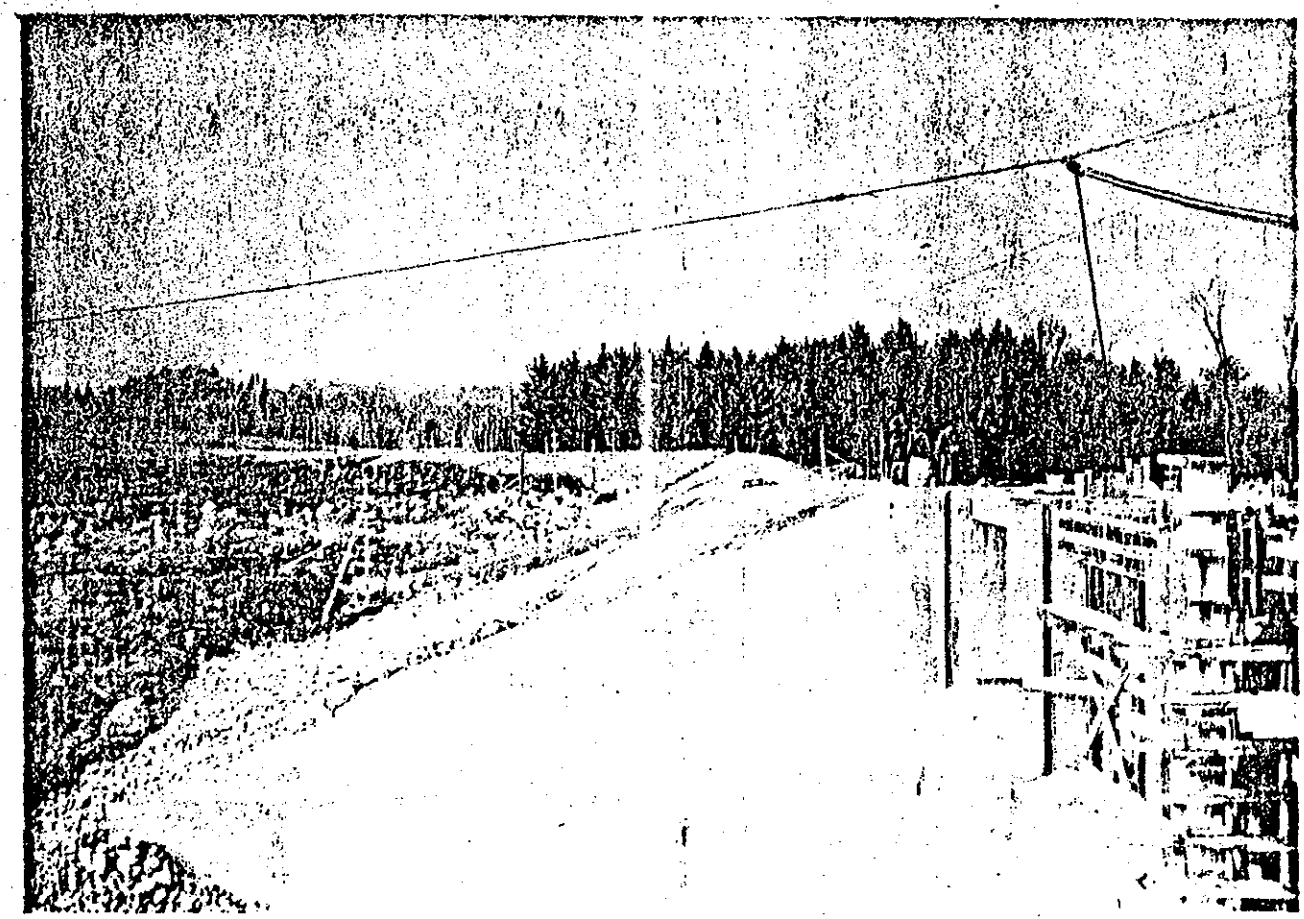
OWNER

Tabulation By A.A.N.&R.L.T. Date December 13, 1938.



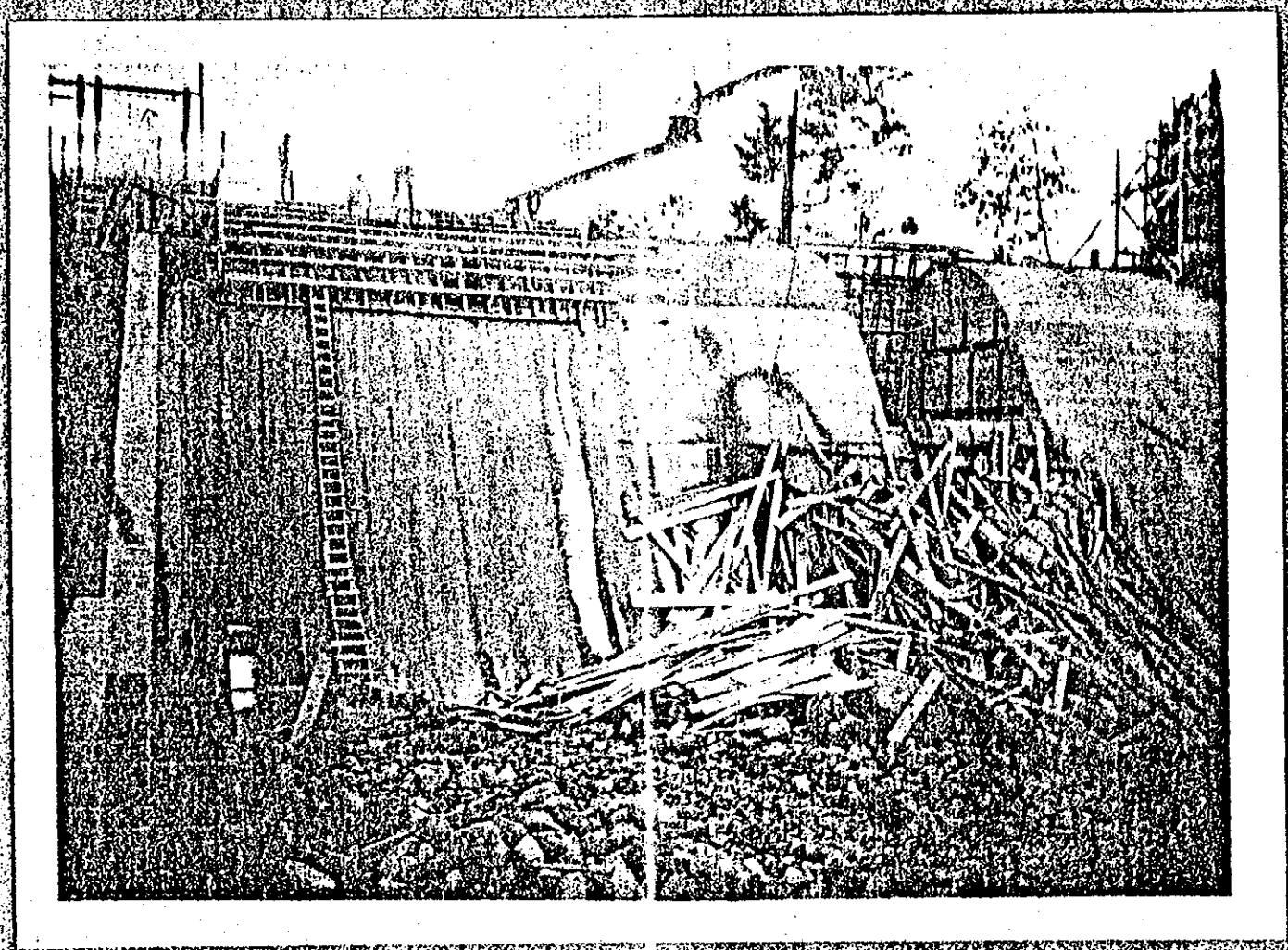
#174 View taken from same position as #173, showing north of #173, 3:07 P.M. September 24, 1926.

Jackman Development.



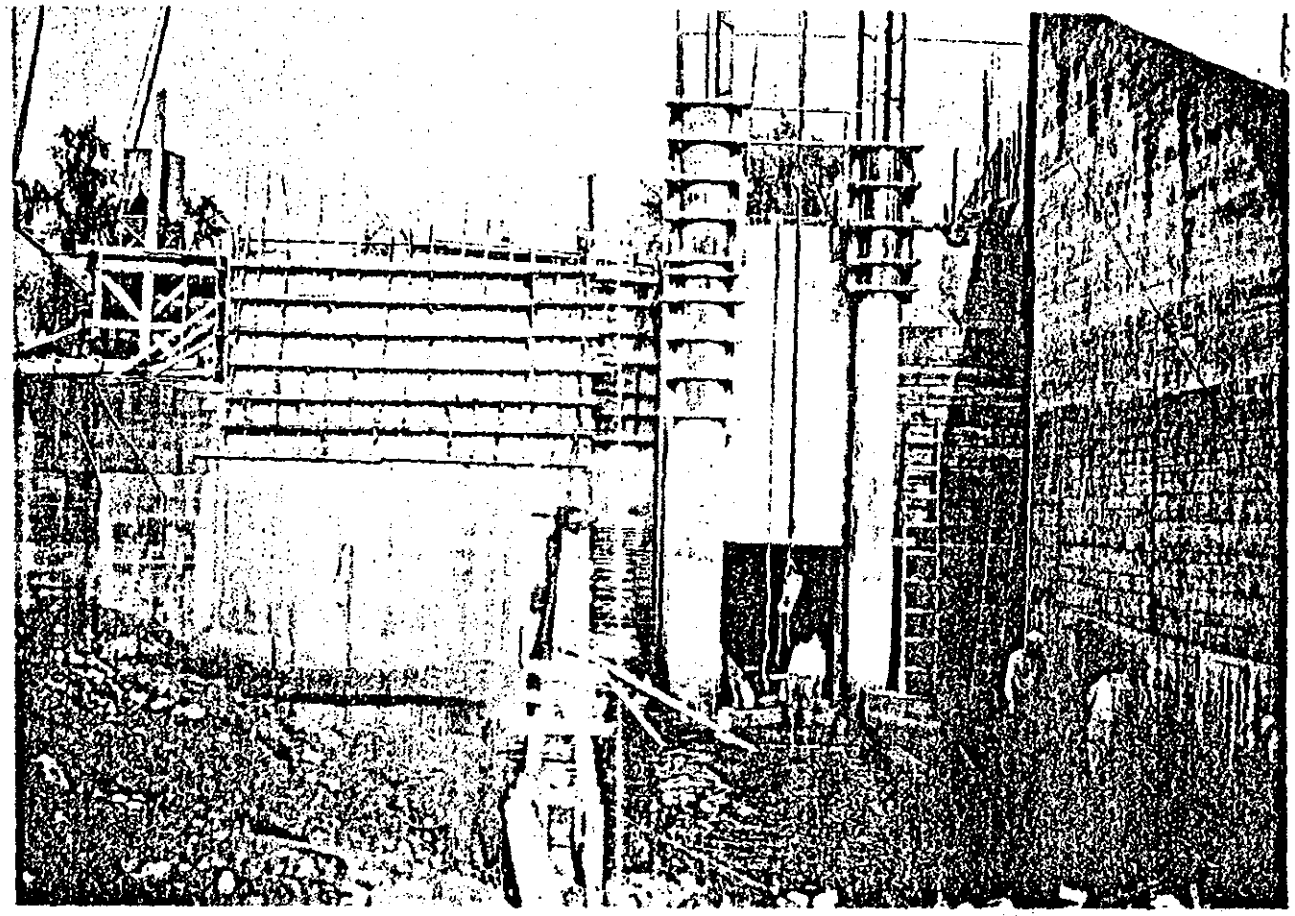
#215 View taken from a position at the northwest corner of intake showing along north dike, 2:30 P. M., November 13, 1926.

Jackman Development.



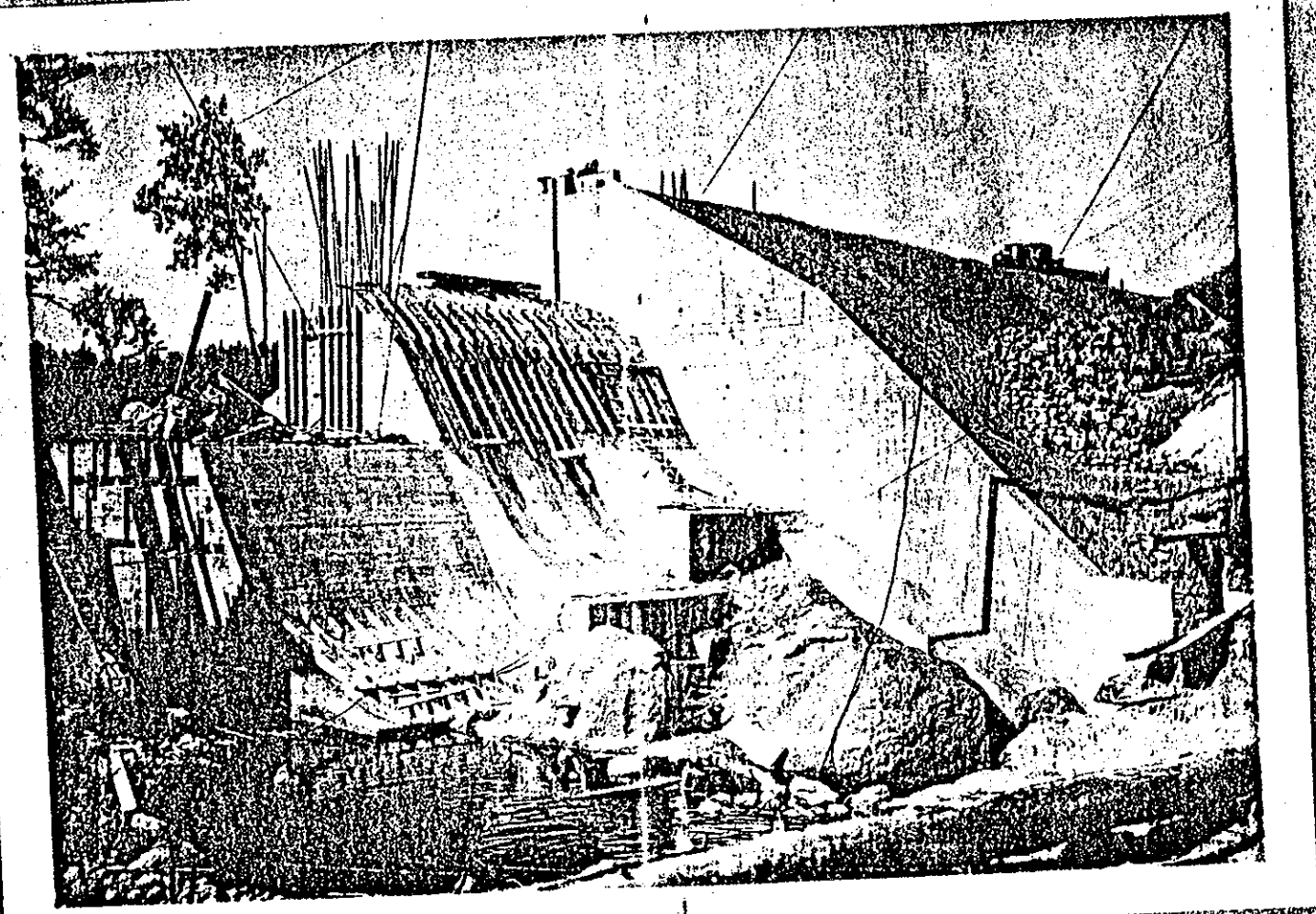
#193 View taken from same position as #191 showing south of #192
3:52 P. M. October 9, 1926.

Jackman Development.



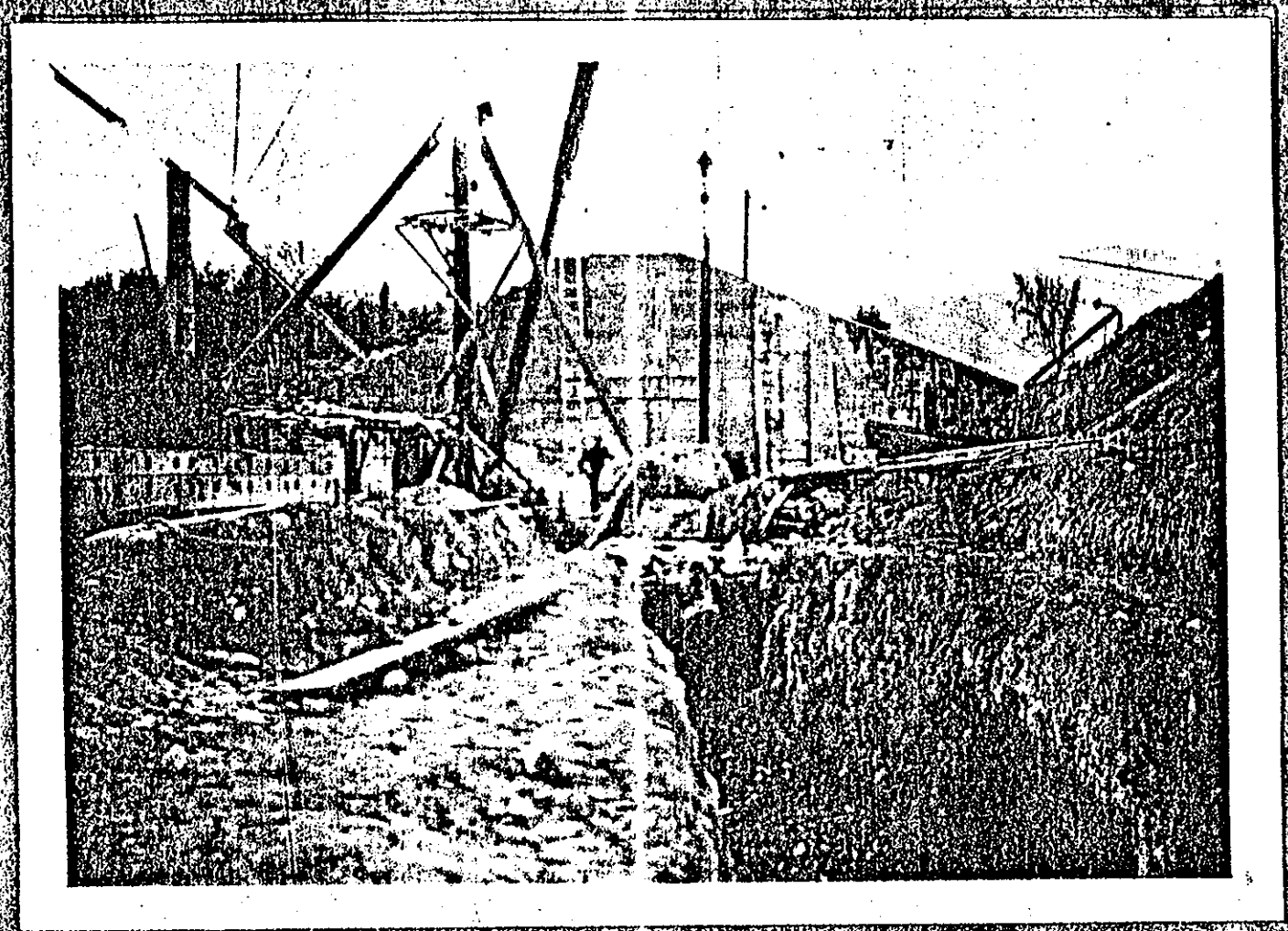
#172 View taken from a position at about CL 0+17, BL 0-100, showing intake and sluiceway 3:00 P.M. September 24, 1926.

Jackman Development.



#167 View taken from same position as #164 showing north #166, 12:18 P. M, September 20, 1926.

Jackman Development.



#145 Taken from a position on old hill road about B10 showing north abutment wall 2:30 P.M. August 26, 1926.

Jackman Development.

121. Jackman Development. View taken of north dike from old road looking north. 12:30 P.M., July 1, 1926.

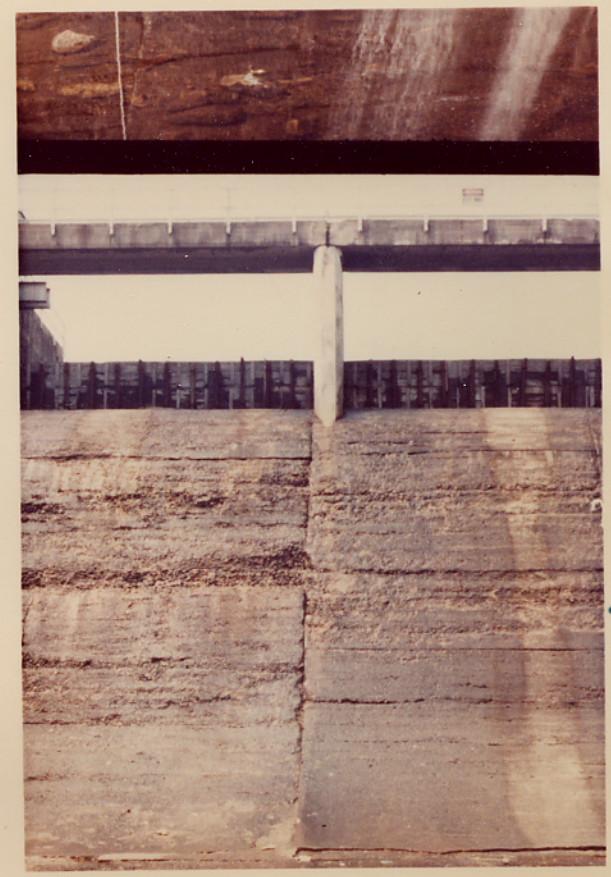
APPENDIX C

INSPECTION PHOTOGRAPHS

Photo No.	Description
1-6	Sequence of 6 photos taken clockwise from downstream of dam looking west toward downstream face of spillway showing south abutment; weepholes in wingwall, rectangular outlet for low level discharge at south end of spillway, spillway; weepholes in north abutment; downstream end of north abutment.
7	View from north end of spillway looking south toward south dike, showing trees on dike.
8	Looking west toward wet area downstream of south abutment of spillway. This area is more of less over the penstock and adjacent to the wingwall on south side of channel.
9	Seepage occurring at south side of penstock trench downstream of dam. May be groundwater discharging from adjacent high ground, may be from dam. Estimated rate - a few gallons per minute. No leakage from south (hill) side of trench further downstream.
10	Drain pipe that discharges adjacent to downstream end of north abutment. Pipe is rusted. Seepage coming out underneath pipe. Appears to be coming from roadway immediately above. Does not appear to be seepage from dam.
11	From service bridge looking toward channel downstream of spillway.
12	From north end of service bridge looking north along north dike showing bare soil on crest and trees and brush.

1

2



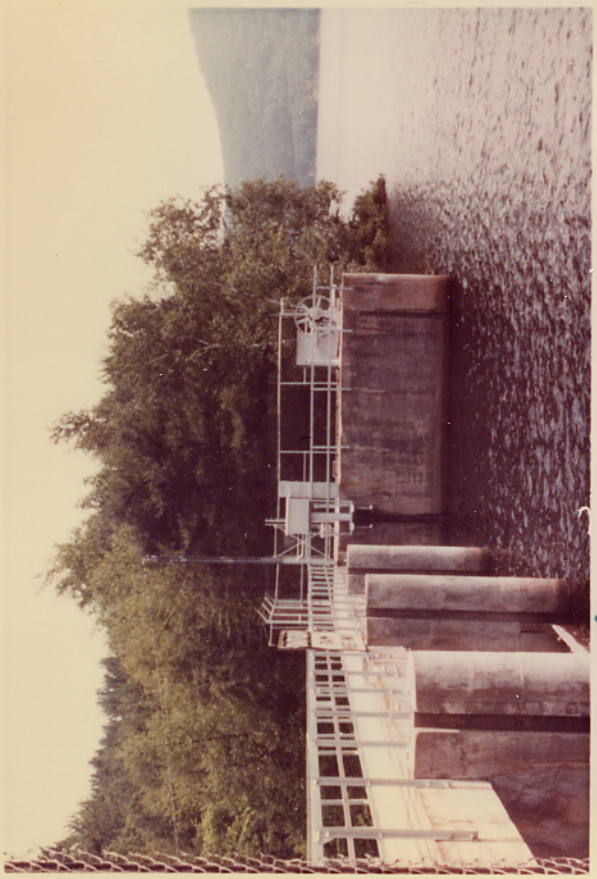
3

4

5

6

7



8

9

10

11

12

APPENDIX D

HYDROLOGIC COMPUTATIONS

WATERSHED MAP

BY T.T.C DATE Jun 78 PROJECT Army Corps Engineers SHEET NO. 1 OF 8

CHKD. BY DATE Dam Safety Inspection - Lake Franklin Pierce JOB NO. 8-090

Lake Franklin Pierce — Jackman Dam

I. Hydrology & Hydraulic Data

a) Drainage Area : Lake Franklin Pierce has total drainage area of about 69.0 sq. mile, in which, 33 sq. miles drains into Highland Lake (which is located at upstream of Lake Franklin Pierce) Highland Lake has two outlets; the south outlet discharges into Island Pond then flows to North Branch of Contoocook River to Lake Franklin Pierce, but the North outlet discharges through Shedd Brook to Contoocook River, downstream of Lake Franklin Pierce. Due to lack of information concerning Highland Lake, the drainage area for Lake Franklin Pierce will be the total 64.1 sq. mile so to be on the safe side. Currently, Highland Lake has been inspected by other Engrs., when information is available, readjustment of the basin area to determine its effect to Lake Franklin Pierce is necessary.

b) Basin Characteristics :

The watershed for Highland Lake is narrow in shape. The main stream runs from North to South, with steep slopes from both east and west sides. For Lake Franklin Pierce, its own watershed is also a narrow one but runs from west to east and has steep slopes from both north and south sides. But because there are few reservoirs in this 64 sq. mile watershed, we classify it as steep to rolling type of basin.

c) Water Surface Area: The water surface area for Lake Franklin pierce at its top of of spillway is about 520 acres

d) Storage Capacity : Based on the data from N.H Water Control Commission, the top 24 ft has storage capacity of 9200 Acre-Ft

e) Dam & Spillway : Max. Height 32 Ft

Length of Dam : Over all length of dam is about 1870 Ft includes earth fill, ogee concrete spillway and earth stone concrete sections.
Top of Dam at elevation 776.2 M.S.L.
Spillway = Length of spillway is about 104 Ft total, contains 4 bays, Each bay has vert spillway 26 Ft.
Spillway crest at El. 763.2 MSL.
Top of Flashboard at El. 767.7 MSL.
Waste gate = 4'x4'
Penstock = 7.5' ϕ concrete – wood pipe with a length of about 6700 ft. has a hydraulic head of 168 ft. when water surface near top of dam.

f) Estimated Peak Probable Max. Flood Flow

PMF = 1300 cfs/55 mile for Mountainous Watershed (Steep slopes)
= 1080 cfs/55 mile for rolling land watershed.

Therefore, the Peak inflow for PMF
= (1300 + 1080) x 69/2 = 82110 cfs

Say 82,000 cfs

g) Size & Hazard Classification

Based on Army Engrs' standard, the dam is intermediate in size.
Though, there are Hillsboro Lower Village about 2000 ft. downstream, Hillsboro about 2 miles away

and 7 miles downstream to Henniker, the population density are not high, the hazard classification should between significant to high, if dam failure.

h) Spillway Capacity & Surcharge Storage Capacity:

Use C=3.7, Length = 104

Water Surface El., Ft	Head Ft	Spillway capacity, Cfs	Penstock & Waste Gate Capacity, Cfs	Surcharge storage Ac-Ft.
763.2	0	0	1380	0
766.2	3	2054	1386	1560
770.2	7	7320	1391	3640
774.2	11	14,418	1396	5720
776.2	13	18,524	1398	5760

$Q_{spillway} = CLH^{3/2}$

Due to unknown of tail water effect during high flood flow, the flow from 4'x4' waste gate were assumed as constant of 1000 cfs ($= A\sqrt{2gH/k}$, $k=2.2$, H use 150)

Penstock capacity was computed by using Chezy-Darcy equation and minor losses terms combine with Moody Curve. For Wood-stave, rough surface pipe $\epsilon = 0.003$ ft since flow in penstock generally are complete turbulence flow, f almost independent of Reynolds number, therefore use $f = 0.0017$ for $\epsilon/D = 0.0004$.

$$\therefore H_L = f\frac{L}{D}\frac{V^2}{2g} + K\frac{V^2}{2g} = \left(f\frac{L}{D} + K\right)\frac{V^2}{2g}$$

$$= \left(0.0017 \times \frac{6700}{7.5} + 1.5\right)\frac{V^2}{2g}$$

$$= \frac{3.02}{64.4}\frac{Q^2}{A^2} = 0.047\, Q^2/A^2 = 0.00106\, Q^2$$

$\therefore Q = \left(\frac{H}{.00106}\right)^{1/2}$ For Water at Crest of Spillway

$H = 168 - 13 = 155$

After Water surface above Elev. 776.2, it will overtopp the dam.

The max. spillway capacity = 18,524 cfs

Waste gate & Penstock max. Capacity = 1400 Cfs

Total max. discharge Capacity = 19,930 say 20,000 cfs

the maximum discharge capacity = $\frac{20,000}{82,000} = 0.244 \simeq 25\%$ of peak PMF

After overtopping use the dam as broad-crest weir, but due to the facts that tree and brush growth was found in abundance on both banks upstream and downstream, only half of the length were used in computing the height of surcharge.

Water Surface Elev. Ft,	Head Ft (H)	Spillway Capacity cfs	Broad Crest * Weir Capacity cfs	Penstocked Waste Gate cfs	Surcharge Storage Acre-Ft
780.2	17	26,972	20,196	1403	8840
782.2	19	31,869	37102	1405	9880
784.2	21	37,031	57123	1407	10,920

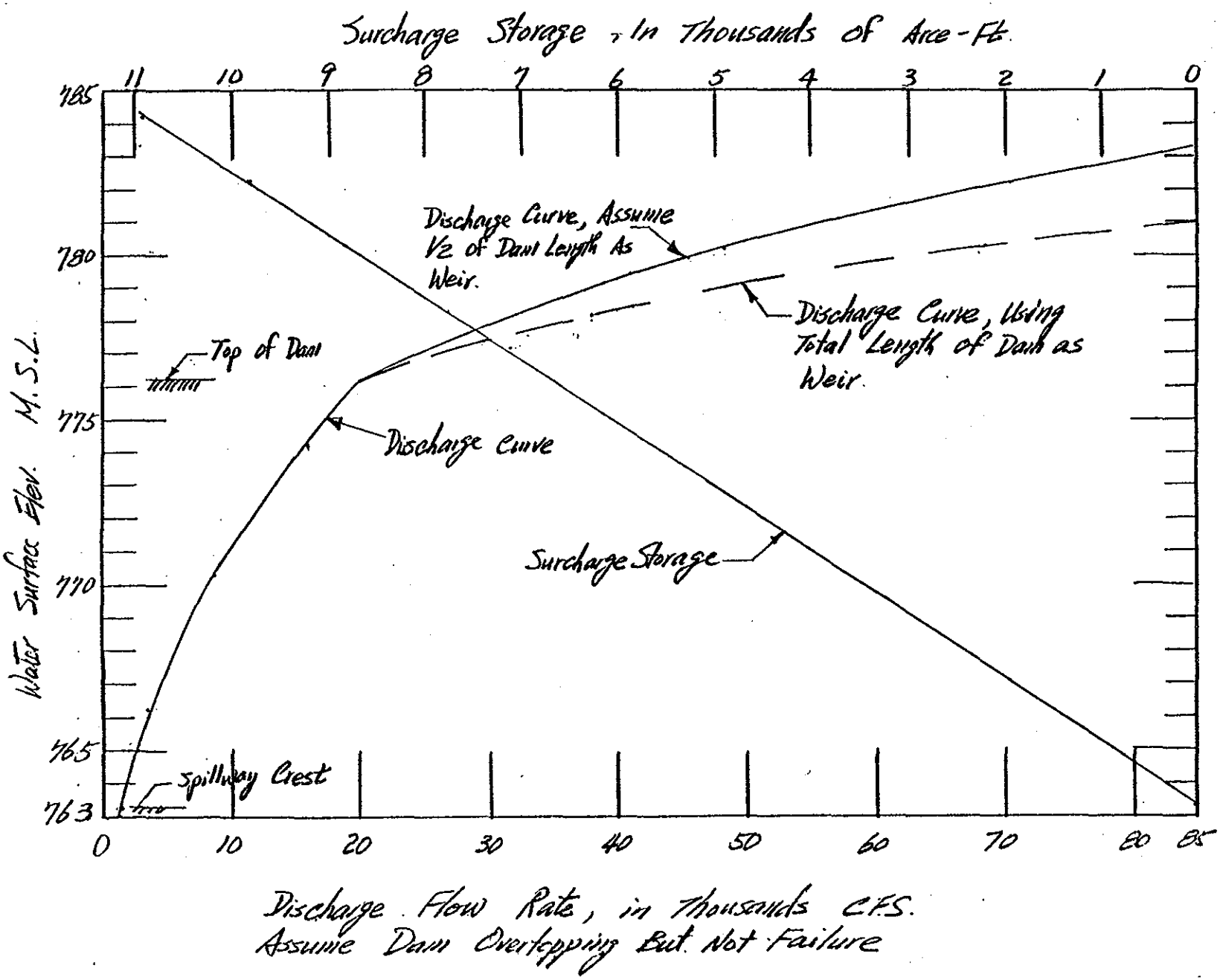
* $Q = 2.7 h^{3/2} L$ $L = 1870/2 = 935$

$h = H - 13$

If tree and brush have been cut, $Q = 2.7 \times h^{3/2} \times 1870$

$= 40392$ cfs for water surface at El. 780.2

$= 114,246$ cfs for " at El. 784.2



BY T.C. DATE Aug. 78 PROJECT Army Corps Engrs. SHEET NO. 5 OF 8

CHKD. BY DATE Dam Safety Inspection - Lake Franklin Pembroke JOB NO. 8-090

WHITMAN & HOWARD, INC.
45 WILLIAM STREET, WELLESLEY, MASS.
Engineers and Architects

ii) Estimating Effect of Surcharge Storage On Peak PMF

(1) For QP1 = 82,000 cfs, from Discharge Curve with ½ Dam as broad crest weir, H_1 = 783 - 763.2 = 19.8 Ft

$STOR1 = 19.8 \times 520 \times 12 \times 0.081563 / 64.1 = 3.01$ inch

$QP2 = 8200\left(1 - \frac{3.01}{19}\right) = 69009$ cfs

$H_2 = 782.2 - 763.2 = 19$

$STOR2 = 19 \times 9.753 / 64.1 = 2.89$ inch

$STOR_{AVE} = (2.89 + 3.01)/2 = 2.95$ inch

$QP_3 = 7200\left(1 - \frac{2.95}{19}\right) = 69265$

$H_3 = 782.3 - 763.2 = 19.1$

$STOR_3 = 782.3 \times 9.753 / 64.1 = 2.89$ inch

$STOR_{Ave} = \frac{2.89 + 2.95}{2} = 2.92$ inch

$QP_4 = 8200\left(1 - \frac{2.92}{19}\right) = 69397$ cfs

Say 69,900 cfs which is peak discharge flow
Surcharge Height = 19.1 Ft. ±
Overtopping Height = 6.1 Ft ±

(2) From Discharge Curve with Total length of Dam as weir; i.e. Assume all tree and brush will be cleared up
For QP1 = 8200 cfs H = 779.8 - 763.2 = 16.6 Ft.
STOP1 = 2.52 inch
$QP2 = \left(1 - \frac{2.52}{19}\right) = 71.099$ cfs
H_2 = 780.4 - 763.2 = 17.2 Ft.

$STOR2 = 2.02$ inch

$STOR_{Ave} = (2.52 + 2.02)/2 = 2.27$ inch

$QP3 = 8200\left(1 - \frac{2.57}{19}\right) = 70908$ cfs

$H3 = 780.4$ so, use $Q = 71000$ cfs as the peak discharge

Surcharge Height = 1.72 Ft ±
Overtopping Height = 4.2 Ft ±

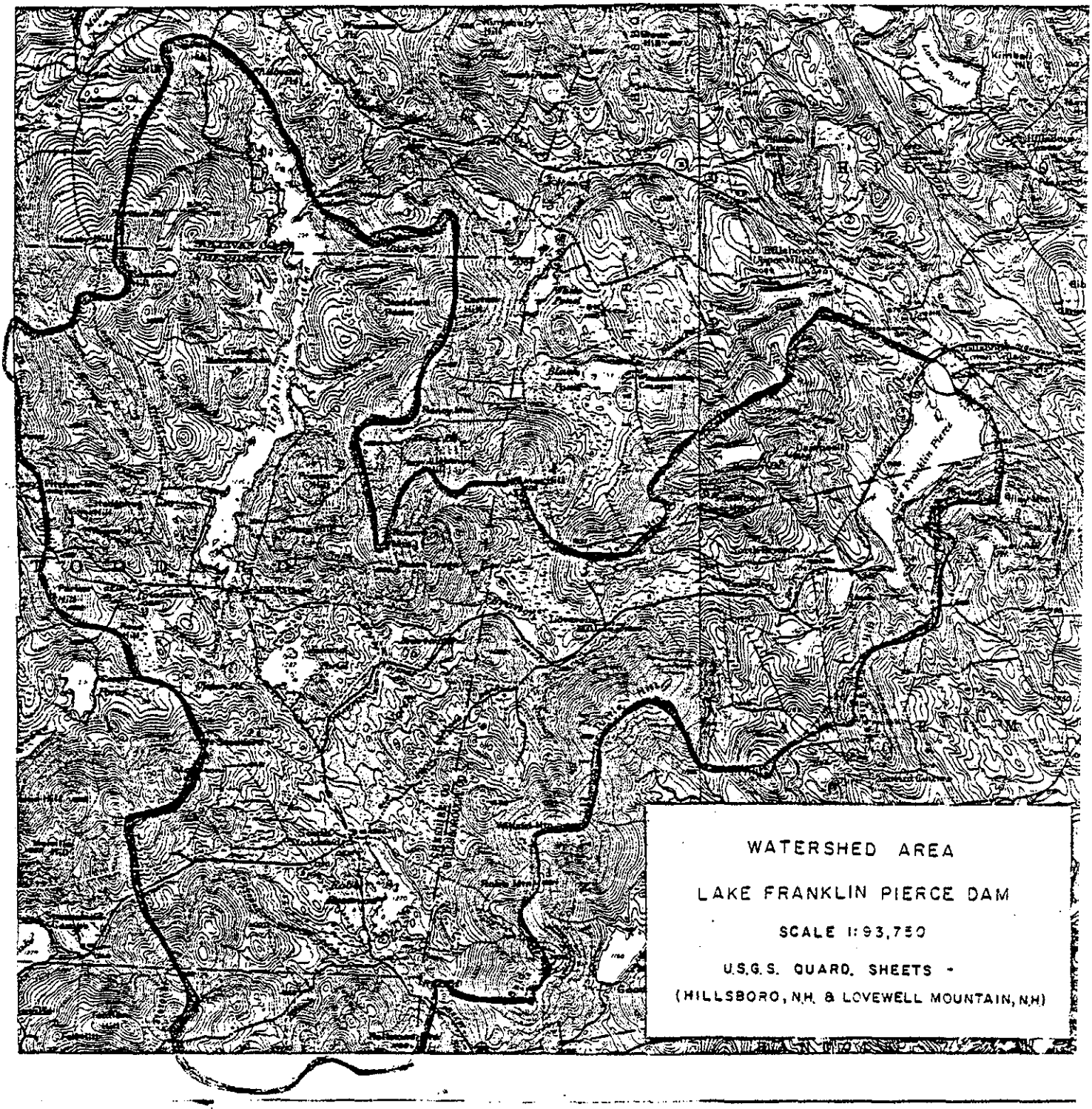
II. Conclusions & Comments

a) The estimated test peak inflow of 82,000 cfs is based on the total water shed of Lake Franklin Pierce. But the upstream Highland Lake has two outlets, one discharge to downstream of Lake Franklin Pierce. Since the analysis of Highland Lake is not known at this time, this peak inflow is somewhat on conservative side. But even assuming that half of the watershed area of Highland Lake discharges to downstream of Lake Franklin Pierce, the peak inflow of PMF still amount to about 62500 cfs. The maximum spillway capacity, selecting wave effect, including penstock and waste conduit only amount to 20,000 cfs, which is still only about 30% of the peak inflow. Therefore, hydrologically, the spillway is too short.

b) The peak inflow even with the consideration of using the whole length of the dam as spillway, it will still overtop by 4 feet, which may still cause the dam failure. It all depends on the length of time of overtopping and the pattern and route of flow during overtoppies. An auxiliary spillway is needed.

c) If auxiliary spillway should be considered, detail hydrology and hydraulic analysis should be conducted to determine the length of spillway required.

d) the heavy growth along both upstream and downstream face of the dam make inspection of seepage or any other problem along the earth embankment very difficult. It is suggested that the owner should first clean up all brush and small trees. As for large trees, cutting down should be careful, due to roots (probably) deep into the embankment; remove the roots and recompaction may be needed.


WATERSHED AREA
LAKE FRANKLIN PIERCE DAM
SCALE 1:93,750
U.S.G.S. QUARD. SHEETS -
(HILLSBORO, N.H. & LOVEWELL MOUNTAIN, N.H.)

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(10) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
NH	119	NED	NH	011	02				LAKE FRANKLIN PIERCE DAM	4308.7	7156.9	01AUG78

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
JACKMAN DAM	LAKE FRANKLIN PIERCE

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	05	NORTH BRANCH CONTOOCOOK RIVER	HILLSBOROUGH	3	2775

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES (27) MAXIMUM (ACRE-FT.)	(27) NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
RECTPG	1927	HR	43	38	12400	8360	NED	N	N	N	N	01AUG78

(28) REMARKS

(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) SPILLWAY TYPE	(32) SPILLWAY WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) POWER CAPACITY PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	1870	C	104	18500		3.4										

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
PUBLIC SERVICE CO OF NH	VAUGHAN ENGR	JACKMAN DEVELOPMENT RLTY

(49) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NH WATER RES BD	NH WATER RES BD	NH WATER RES BD	NH WATER RES BD

(53) INSPECTION BY	(54) INSPECTION DATE DAY | MO | YR	(55) AUTHORITY FOR INSPECTION
WHITMAN + HOWARD, INC	22JUN78	PL 92-367

(56) REMARKS